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Key concepts for Integrated Urban Water Management infrastructure planning: Lessons from Melbourne

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A B S T R A C T

"Integrated Urban Water Management plans" consider all water services simultaneously to determine optimal infrastructure solutions. They create many benefits, including unlocking opportunities for water reuse. This paper conducts preliminary assessment of nine IUWM plan case studies from Melbourne. It finds inconsistencies between plans in relation to environmental and liveability objectives, and option identification methods, and also that many IUWM options perform worse than conventional water supplies in regards to energy. The most consequential finding is that the plans do not include scenario planning and therefore fail to consider infrastructure performance regarding resilience to future uncertainties around population and climate change.

1. Introduction

1.1. Urban water management

Urban water management has traditionally involved the provision of water supply, sewerage and drainage services to customers through a network of buried pipes (Marlow et al., 2013). Across the world there are large variations in regards to how these water services are managed, particularly in relation to division of responsibilities between utilities, state and local governments (Baietti et al., 2006). In some countries there are large numbers of vertically integrated water utilities, or municipalities, who control all water services but only over a small geographical area. In other countries there are horizontally integrated utilities, or state and national government departments, which cover a wide area but only one or two water services, and everything else in between (Marques and De Witte, 2011).

However regardless of the organisational and governance arrangement utilised, it has always been the standard practice of water utilities to consider long-term planning of each water service separately (Mukheibir et al., 2014; Anderson and Iyaduri, 2003). Generally particular departments are given responsibility for the planning, construction and maintenance of infrastructure for one water service (Furlong et al., 2016c). This traditional segregated model makes planning relatively simple by allowing planners to monitor supply and demand trends for each water service separately, and wait until appropriate times to implement infrastructure augmentations (Closas et al., 2012).

Public water managers face a variety of increasing challenges. Two of the most serious challenges are long-term climate change and population growth and migration trends (Howden et al., 2007). Population changes have led to increasing urbanization and pollution, and have contributed to ecological damage, urban flooding, and water scarcity (Grimm et al., 2008; Sharma et al., 2010; Vörösmarty et al., 2010).

For this reason using scenario planning to design water infrastructure to be resilient to a variety of possible future population and climate change contexts has been widely recognised as an important practice (Luis et al., 2016). Various planning methodologies have been developed to assist water utilities in using potential scenarios and adaptive/flexible approaches for the planning of urban water infrastructure. Generally the aim is to make water systems "resilient", meaning that they are able to effectively deal with a variety of possible futures (Haasnoot and Middelkoop, 2012; WSAA, 2016).

1.2. Water sector shift towards integrated approaches

As a response to challenges there has been a gradual paradigm shift globally towards the idea that water management should take an "integrated" approach. This shift has taken many forms, and

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been known by many names (Furlong et al., 2015). Integrated Water Resources Management (IWRM), the most widely recognised term, is an approach that predominantly has a river basin scale water resources focus, and gained popularity on the tail of a number of high profile international conferences from 1977 to 2002 (Mukhtarov, 2008). Although IWRM is the most recognised term for integrated approaches within the water sector globally, it is typically used in relation to the planning of water resources and water allocations, which occurs at a large, generally river basin scale (Warner et al., 2008).

This paper relates more closely to the idea of Integrated Urban Water Management (IUWM), which has become popular more recently through the works of the World Bank, CSIRO, Global Water Partnership and the SWITCH project (Global Water Partnership, 2012; Closas et al., 2012; Howe et al., 2011; Furlong et al., 2016a). IUWM means different things to different people (Furlong et al., 2016d), and its definition can be very broad such as (Global Water Partnership, 2012):

> "Integrated urban water management (IUWM) offers a set of principles that underpin better coordinated, responsive, and sustainable resource management practice. It is an approach that integrates water sources, water use sectors, water services, and water management scales. It (1) recognises alternative water sources, (2) differentiates the qualities and potential uses of water sources, (3) views water storage, distribution, treatment, recycling, and disposal as part of the same resource management cycle, (4) seeks to protect, conserve and exploit water at its source,(5) accounts for nonurban users that are dependent on the same water source, (6) aligns formal institutions (organisations, legislation, and policies) and informal practices (norms and conventions) that govern water in and for cities, (7) recognises the relationships among water resources, land use, and energy, (8) simultaneously pursues economic efficiency, social equity, and environmental sustainability, and (9) encourages participation by all stakeholders."

For the purposes of this paper this broader definition can be scoped to include only: (1) coordinated planning of all water services (water supply, sewerage and drainage) (Mukheibir et al., 2014; Makropoulos et al., 2008; Dobbie and Brown, 2013), (2) consideration of decentralised wastewater and stormwater reuse opportunities (Mitchell, 2006; Ferguson et al., 2013; Sharma et al., 2010), and (3) explicit consideration of liveability and ecosystem protection (Brown et al., 2009; Ferguson et al., 2013; WSAA, 2014).

Liveability is a term that includes a wide array of concepts. In a broad sense "liveability" means everything that makes an urban area pleasant to live in, and is therefore related to what a particular community values. The water industry has been discussing its role in, and contribution to liveability for a number of years (WSAA, 2014). Essential services that water utilities provide, including water supply, sewerage and drainage, are necessary for attaining liveable cities. However there are also "non-essential services" which relate to liveability including: community connection, local identity, natural environments/biodiversity, urban form/amenity, leisure/recreation, and ecological footprints (Holmes, 2013). In relation to these non-essential services there is a lack of clarity around what exactly the water sector's role is, and how this should be done.

The idea that the water utility sector should be involved in contributing to these non-essential services has been a continued focus for a number of Australian researchers, who have been promoting a concept known as "Water Sensitive Urban Design" (WSUD) (Brown and Clarke, 2007). WSUD is an ideology that promotes the installation of stormwater management devices such as rain gardens, wetlands and swales throughout urban areas, to simultaneously improve all of these non-essential liveability services (Wong, 2006).

1.3. "Integrated" water infrastructure planning in Melbourne

Water infrastructure planning is a subset of water management that specifically involves identifying, comparing, and selecting infrastructure options to achieve best community outcomes. In some parts of Australia, particularly in Melbourne, there have been massive institutional water utility and government policy changes which have mainstreamed the integrated planning of urban water infrastructure (Ministerial Advisory Committee, 2012; Furlong et al., 2015; Department of Environment, Land, Water and Planning, 2016).

The process of planning water supply, sewerage, drainage, liveability and ecosystem services simultaneously to determine optimal long-term infrastructure solutions can be described as the creation of "IUWM plans" (CSIRO, 2010). In Melbourne IUWM plans are conducted at a sub-regional or local scale, particularly focusing on growth areas on the city's fringes (Furlong et al., 2016a). IUWM plans are generally commissioned by public water utilities and created by private consultancies (Furlong et al., 2016c). They are conducted as far in advance as possible, ideally well before construction activities have begun (Wilson et al., 2013).

Consideration of infrastructure for multiple services in a single planning process allows, among other things, the identification of water reuse options, through the consideration of water supply, sewage and stormwater supply and demand balances (Fam et al., 2014). Water reuse, including wastewater recycling and also stormwater treatment and harvesting, is often considered to be an "IUWM option/project" (Furlong et al., 2016a). A large component of all IUWM plans involves comparing unconventional IUWM options to a conventional, or "business as usual (BAU)" option, on a total community cost basis (Makropoulos et al., 2008).

A wide spread of IUWM options can be seen in Table 3, and more detailed examples of IUWM infrastructure can be found in Furlong et al. (2016a), which provides case studies on four of Melbourne's stormwater harvesting projects, and three of Melbourne's wastewater reuse projects. These projects include a range of scales, water uses, and project leaders.

Within Australia's water sector many believe that IUWM plans are able to unlock better infrastructure options than what would be achieved through the traditional segregated planning approach (Anderson and Iyaduri, 2003). 82% of surveyed water industry experts believe that IUWM is going to be either "very" or "extremely" relevant to the future of the urban water sector (Furlong et al., 2016d). In Melbourne's water industry reports it is common to find statements similar to the following (Yarra Valley Water and Melbourne Water, 2013):

> "Compared to a traditional servicing approach, the adoption of [IUWM] solutions can deliver higher community value by optimising the benefits and costs of each investment."

Another key function of IUWM plans is to establish relationships between stakeholders and help to build a joint vision. Without such a joint vision efforts towards improving water services can be fragmented, and even conflicting (Howe et al., 2011).

1.4. Process for creating Integrated Urban Water Management plans

All planning processes involve a number of key steps which can be referred to as a planning framework (see Fig. 1). Furlong et al. (2016b) compared a number of water infrastructure planning frameworks, including both traditional and IUWM planning, and found that they were all to some extent based on the rational